New Holland Mouse *Pseudomys novaehollandiae* (Rodentia: Muridae) in South Gippsland, Southern Victoria. Part Two - Conservation and Management

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Abstract

A survey for New Holland Mouse *Pseudomys novaehollandiae* populations in areas of South Gippsland, conducted by the then Department of Conservation and Natural Resources (currently Department of Natural Resources and Environment) located two previously unknown populations of New Holland Mouse numbering15 individuals on the Yanakie Isthmus, Wilsons Promontory National Park. However, populations which were known from the Promontory and McLoughlins Beach (on Ninety Mile Beach) are believed to be no longer present. The species was not detected at two further areas formerly known to support it, Dream/Hummock Island and Mullungdung State Forest; however, further surveying at both areas is recommended. At Wilsons Promontory, New Holland Mice were found in vegetated sand dune systems which had not been burnt for 20-30 years. This finding indicated that New Holland Mice inhabiting such habitat were not necessarily reliant on an actively regenerating understorey as they are in other habitats (e.g. coastal heath). Their habitat at Wilsons Promontory appears to be under threat from Coast Tea-tree *Leptospermum laevigatum* and Coastal Wattle *Acacia sophorae* invasion. Recommendations for appropriate management of the New Holland Mouse populations and their habitat are provided. Restoration of the native grassland - open woodland vegetation types in the vicinity of the populations will assist viability of the species in the long-term. Dunes systems in other areas of South Gippsland similar to those inhabited by New Holland Mice at Wilsons Promontory should be surveyed for this species. The Wilsons Promontory populations currently represent the only populations of New Holland Mice known from South Gippsland. (*The Victorian Naturalist* 1996. 113, 281-288)

Introduction

The New Holland Mouse *Pseudomys novaehollandiae* (family Muridae) has a patchy distribution on coastal and hinterland areas of central eastern New South Wales, central southern Victoria and north-eastern Tasmania (Kemper 1995). Habitats utilized by New Holland Mice include coastal heathland, woodland and open forest with a heathy understorey, swamp edges and vegetated sand dunes. Habitats with heathy understoreys that are actively regenerating provide particularly favourable habitat (e.g. Keith and Calaby 1968; Posamentier and Recher 1974; Cockburn 1980; Wilson 1991; Menkhorst 1995; Quin 1996). In Victoria the New Holland Mouse is classified as endangered and a number of processes threaten populations (CNR 1995; Menkhorst 1995; Seebeck *et al. in prep.*). A survey in South Gippsland, central southern Victoria during 1992-93 determined the species was in decline, being located only at Wilsons Promontory (Quin 1996). This paper outlines management recommendations for New Holland Mouse at the Promontory and other sites where it has been recorded in South Gippsland.

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Study Sites, Materials and Methods

The location of study sites and a full description of materials and methods utilized in determining the distribution of New Holland Mouse occur in part 1 of this series (Quin 1996). Three sites which formerly supported New Holland Mice, Mullungdung State Forest, Dream/Hummock Island and Wilsons Promontory National Park (Yanakie Isthmus) were trapped. Trapping also occurred at Won Wron State Forest (for which no New Holland Mice records exist) which is adjacent to Mullungdung State Forest. Additionally, hair-tubes were set and predator scats collected at Mullungdung and Wilsons Promontory; hair-tubes were also set at Won Wron. Sites chosen were based on those of past records provided by Gilmore (1977) and Barbara Wilson (*pers.*

Table 1. Mammal species detected by Elliott trapping at study locations in South Gippsland; provided from Quin (1996).
1 = No. of Sites; 2 = No. of Trapnights; 3 = Sampling Period ; 4 = Species Captured; 5 = Total No. of Captures; 6= No. of individuals (in brackets). (Note : site specific data is provided CNR (1993) and Quin (1994). Cage trapping was also employed at Wilsons Promontory and totalled 38 trapnights).

Location	1	2	3	4	5	6
Mullungdung State Forest	18	1253	19/11/92-04/04/93	Brown Antechinus	43	(35)
				Eastern Pygmy-possum	8	(6)
				Bush Rat	26	(13)
				Swamp Rat	7	(4)
				Black Rat	7	(5)
				TOTAL	**91**	**(63)**
Won Wron State Forest	5	296	19/12/92-23/12/92	Brown Antechinus	13	(8)
				Bush Rat	1	(1)
				Black Rat	2	(1)
				House Mouse	1	(1)
				TOTAL	**17**	**(11)**
Dream/Hummock Island	4	190	25/03/93-27/03/93	Swamp Rat	35	(29)
				House Mouse	33	(33)
				TOTAL	**68**	**(62)**
Wilsons Promontory National Park (Yanakie Isthmus)	6	562	15/02/93-24/04/93	Bush Rat	23	(15)
				Swamp Rat	10	(4)
				House Mouse	11	(11)
				New Holland Mouse	30	(15)
				TOTAL	**74**	**(45)**

comm.) for Mullungdung; Peter Menkhorst (*pers. comm.*) for Dream/Hummock Island; CNR (1993) for Wilsons Promontory. Additional sites at the Promontory and those of Won Wron were chosen because of their diverse, heathy understorey, an attribute typical of New Holland Mouse habitat (see references in 'Introduction'). The survey was conducted from between November 1992 to April 1993.

Results

Tables 1-3 (mammal species found) and Table 4 (vegetation at trapping locations) of Quin (1996) summarise results of the survey; Table 1 is re-produced in this paper. New Holland Mice were located only on the Yanakie Isthmus of Wilsons Promontory, and only via trapping, not hair-tubing or predator scats. They were found in vegetation on sand dunes which had not been burnt for 20-30 years. Saw Banksia *Banksia serrata* and Drooping She-oak *Allocasuarina stricta* formed the overstorey. Spiny-headed Mat-rush *Lomandra longifolia*, Black-anther Flax-lily *Dianella revoluta*, and several shrub species comprised the understorey. Coastal Wattle *Acacia sophorae* and Coast Tea-tree *Leptospermum laevigatum* had invaded parts of the dunes forming dense thickets with little understorey.

Eight male and four female New Holland Mice were trapped at one site, while three males were found at another site. Morphometric data and other details taken from the mice are presented in Quin (1996). New Holland Mice may no longer exist at Mullungdung State Forest, Dream/Hummock Island, or parts of Wilsons Promontory where they once occurred.

Discussion and Recommendations

Mullungdung State Forest

The sites in Mullungdung State Forest where New Holland Mice have been recorded appear to no longer support this species (Quin 1994; 1996). The heathy woodland vegetation communities at these

sites (and many other areas of Mullungdung) were over ten years of age, possibly a post-fire succession stage beyond that favoured by this species. Gilmore (1977) described the 'low heath' habitat where he trapped New Holland Mice and suggested a burning regime which maintained its regenerating nature. He compared this habitat to heath sites in Mullungdung where New Holland Mice were not trapped, and the latter were apparently at a similar stage of succession to many of the sites sampled in 1992-1993. Additionally, studies elsewhere have demonstrated this species prefers heath actively regenerating after fire or other disturbances (e.g. Keith and Calaby 1968; Posamentier and Recher 1974; Braithwaite and Gullan 1978; Fox and Fox 1978; Wilson 1991).

The aforementioned studies indicate that various factors associated with vegetational succession may influence New Holland Mice numbers. It was not possible to isolate the factors responsible for the decline in populations in Mullungdung. Some areas, including one former New Holland Mouse site, had an abundance of Austral Bracken *Pteridium esculentum* in the understorey. Long-term monitoring would have been needed to assess the effect of this plant species on other understorey species. However, its abundance may have reduced the vigor of certain key plant species, for example legume species, which are important food sources (Cockburn 1980). Additionally, structural features may have altered which adversely affected New Holland Mouse populations.

Overall, the heathy woodlands of Mullungdung could potentially provide habitat for New Holland Mice. A burning regime which provides the habitat suitable for this species needs to be formulated. A mosaic of variously-aged heaths over small areas would provide short-term and long-term habitat (see Pye 1991; Wilson 1991). If New Holland Mice are still present in the heathy woodlands of Mullungdung, the populations are likely to be small and habitat manipulation of this kind will undoubtedly be required to avoid population loss. However, it appears that the New Holland Mouse is absent in this State Forest and the establishment of this burning regime would produce habitat suitable for the re-introduction of the species. Re-introduction would also require genetic studies to establish a 'donor' population most similar to those that possibly still exist at Mullungdung. Feral predator control would also be necessary. Small scale trial burns should be conducted in the near future.

Recommendations for Mullungdung State Forest

1. **Develop and implement a burning regime in the heathy woodlands of Mullungdung which is appropriate for the New Holland Mouse; small scale fires implemented at intervals which produce a mosaic of habitats with differing ages are indicated in this regard.**
2. **Conduct further surveys of suitable habitat at Mullungdung State Forest to locate extant populations or demonstrate that the species is locally absent.**
3. **Investigate the potential of Mullungdung to provide suitable New Holland Mouse re-introduction sites, as a long-term aim.**

Won Wron State Forest

New Holland Mice were not captured at the five sites sampled in Won Wron State Forest (Quin 1994; 1996). This species had never been recorded from Won Wron. Gilmore (1977) trapped at two heathland sites in this forest but regarded the vegetation as too old for New Holland Mice. During the present study the heathy woodland sites trapped were perhaps too young (0.8 years after fire) or too old (>50 years); refer Braithwaite and Gullan (1978); Wilson (1991). The heathy open forest sites of at least 50 years post-fire age were also possibly too old to support New Holland Mice. However, evidence of a much more recent burn at these sites was apparent and the low and diverse heath understorey of the open forest sites did appear suitable for New Holland Mice. It

may still be worthwhile searching on a larger scale for New Holland Mice in Won Wron State Forest.

Recommendations for Won Wron State Forest

1. **Further survey for New Holland Mouse populations in Won Wron State Forest; priority areas to be the young, actively regenerating heathy woodland areas where long-term monitoring sites should be established.**

2. **Following on from (1), further determine the suitability of the heathy woodland and open forest of Won Wron State Forest as habitat for New Holland Mice.**

Dream/Hummock Island

New Holland Mice were captured on vegetated dunes at the south-west point of this island in 1977 (Menkhorst 1995; Peter Menkhorst *pers. comm.*). Some of the dunes appeared to have eroded since 1977, and adjacent vegetated dunes were unsuitable habitat for New Holland Mice. Trapping at three sites further along the seaward coastline of the island, which supported similar vegetation to that of the 1977 site, failed to detect this species (Quin 1994; 1996). Trapping at four sites (of different habitat) on the north-east section of the island also did not detect New Holland Mice (Fauna Survey Group, Field Naturalists Club of Victoria *unpubl.*). New Holland Mice may no longer occur on Dream/Hummock Island.

The survey detected House Mice at a trapping success rate of 17% (cf. 4% recorded by Peter Menkhorst in 1977). Although the available evidence on interactions between New Holland Mice and House Mice living in sympatry tends to suggest the former out-competes the latter (Cockburn 1980; Wilson 1991), the reverse outcome perhaps cannot be ruled out for island populations. The New Holland Mice detected on Dream/Hummock Island in 1977 probably comprised descendants of populations present when the island was connected to McLoughlins Beach some 30 years ago (Tim Buttle *pers. comm.*).

Recommendations for Dream/Hummock Island

1. **The primary dune and swale vegetation along the southern coastline of Dream/Hummock Island should further be assessed with the aim of determining its suitability for New Holland Mice.**

Wilsons Promontory National Park Distribution and Habitat

This survey and others (by the Fauna Survey Group, Field Naturalists Club of Victoria and Deakin University *unpubl.*) have indicated New Holland Mice no longer occur in heathland communities of Wilsons Promontory National Park (Quin 1994; 1996). Much of the heathlands remained unburnt for extended periods prior to the 1970's, and probably reached succession stages unsuitable to New Holland Mice (refer for example Wilson 1991).

In February-April 1993, two populations of New Holland Mice were discovered in sand dune vegetation on the Yanakie Isthmus of the National Park (CNR 1993; Quin 1994; 1996). A follow-up survey during 1994 found further populations comprising at least 59 individuals existed in similar sand dune habitat on the Isthmus (Darren Carman *pers. comm.*) (Figs 1, 2, 3). Generally, this vegetation had not been burnt for 20 - 30 years (Jim Whelan *pers. comm.*). The habitat was, to a degree, comparable with sites on Dream/Hummock Island, although the Yanakie sites were not primary dunes. The floristic composition of New Holland Mice habitat at Wilsons Promontory appeared similar to that described for north-east Tasmanian populations (Pye 1991). Sand dune habitat may be more important for New Holland Mouse populations than previously thought.

The dune systems where New Holland Mice occur are calcareous in composition,

quite steep in parts, and, unlike many of the smaller dunes present on the Isthmus, have not been extensively invaded by Coast Tea-tree and Coastal Wattle. The reasons for this require investigation. Coast Tea-tree in the swales around the dunes containing the New Holland Mouse populations has been slashed as part of a program initiated by the then Department of Conservation and Environment in 1991 to restore Kangaroo Grass *Themeda triandra* native grassland-open woodland vegetation over selected areas of the Yanakie Isthmus. The decline of these grasslands and grassy woodlands has been ascribed to factors associated with European settlement, including inappropriate fire regimes, and the activities of cattle and rabbits (DCE 1992). This program should conserve the habitat of New Holland Mice by reducing Tea-tree encroachment onto the dunes they occupy. This is imperative because trapping in Tea-tree infested dune vegetation did not locate any small mammal species at all, probably due to the lack of ground vegetation (CNR 1993; Quin 1994). Furthermore, New Holland Mice are believed to be extinct at the Red Hill Track site where they were captured in 1973 because of invasion by Coast Tea-tree (*pers. obs.*).

The restoration work includes a proposed 1080 baiting program for the slashed areas which aims to reduce rabbit numbers. This is required to enhance grassland establishment. The grassy areas are to be burnt periodically to maintain their diversity and prevent re-invasion by Coast Tea-tree (DCE 1992). The bait will be placed in slashed swales along a small ploughed groove. However, the program will need modification at sites from which New Holland Mouse is now known. It is not known whether New Holland Mice would take 1080 bait as food. Trapping records indicate New Holland Mice may at least occasionally traverse swales between dunes. In one instance, a swale approximately 20 m wide was crossed; it is not known whether scattered shrubs at one end of the swale were used as cover during the crossing. Another New Holland Mouse crossed a vehicular track bisecting dune vegetation. Consequently it is inadvisable to bait until the susceptibility of New Holland Mice on the Yanakie Isthmus to the proposed 1080 baiting program is determined. Some suggestions for determining their susceptibility are provided in CNR (1993). In the interim, Coast Tea-tree regeneration surrounding the dunes should be systematically slashed. There is also a need to ascertain the extent of distribution and association of New Holland Mice with the dune systems described before the baiting program is conducted.

Changes in vegetation on the Yanakie Isthmus over the last 150 years or so raises the question, 'What habitat(s) did New Holland Mice occupy on the Isthmus before the present?' It is probable that this species occupied sand dunes which would have supported a similar plant species composition to that at the New Holland Mouse sites described in this paper (DCE 1992). The possibility of New Holland Mice also inhabiting grassland areas cannot be ignored. New Holland Mice, which existed at McLoughlins Beach in coastal vegetation, had quite a high proportion of grain in their diet, though invertebrates were also taken (Cockburn 1980). This type of diet would be available in diverse grasslands. Additionally, structural attributes of grassland areas would, apparently, not be grossly different from some of the sedge-lily dominated areas of dunes where New Holland Mice were trapped in 1993. Whether or not the Kangaroo Grass *Themeda triandra* grasslands are habitat of New Holland Mice will only be known when the restoration process is well progressed. The New Holland Mouse populations at Wilsons Promontory provide an ideal opportunity to learn more about this species, especially in what is to a degree atypical habitat.

Densities

The number of New Holland Mice at Site 1 was encouragingly high (12). The trapping arrangement at this site during the February 1993 survey covered an area of approximately 0.8 hectares. Thus, a crude density estimate of New Holland Mice was approximately 12.5 individuals/hectare. However, approximately one third of traps were located in open swales which failed to trap any New Holland Mice. Hence this figure may have under-estimated the densi-

Fig. 1. New Holland Mouse habitat, site 1 on Yanakie Isthmus. Slashed area in foreground, calcareous dune in mid picture.

Fig. 2. Close-up of dune habitat at site 1, Yanakie Isthmus.

Fig. 3. New Holland Mouse habitat, site 5, on Yanakie Isthmus.

ty of mice on the vegetated dunes. Furthermore, on these dunes New Holland Mice apparently selected sites with a specific micro-habitat; Coast Tea-tree thickets with little ground vegetation were avoided. Kemper (1995) noted that New Holland Mice living in optimum habitat can reach densities of 17 individuals/hectare. At Site 5 of the Wilsons Promontory survey, three New Holland Mice were caught over an area of 0.4 hectares (i.e. 7.5 individuals/hectare).

Weights of New Holland Mice at Wilsons Promontory were generally less than those at Otway Ranges (Wilson 1991) and north-east Tasmania (Pye 1991; Kemper 1995), but fell within the weight range of specimens from the central coast of New South Wales (Keith and Calaby 1968). New Holland Mice at the Promontory possessed tail and hindfoot lengths that were within ranges provided by Keith and Calaby (1968) and Pye (1991). The capture of a pregnant female and 'sub-adults' (of approximately 13.0 g) in late February conformed to the spring-summer breeding season determined by Kemper (1995) and Wilson (1991) elsewhere. However, it also suggested breeding could extend into autumn as it does in Tasmanian populations of New Holland Mice (Pye 1991).

Movements

The presence of fallen, dead shrubs on dunes appeared important for short distance movements of at least some of the New Holland Mice. Additionally, the dead shrubs may provide for the mice some cover and protection from predators. Consequently, dead shrubs are seen as important components of New Holland Mice habitat. However, a greater understanding of vegetational succession on the dunes is needed for the management of New Holland Mice.

The 90 m movement of an individual New Holland Mouse in a 24-hour period seemed a considerable distance for an animal of its size. However, Pye (1991), working in Tasmania, recorded a 400 m movement of a New Holland Mouse in a 48-hour period.

Invertebrates - ectoparasites

The three genera of invertebrates collected from New Holland Mice include two ectoparasites: *Pygiopsylla* sp.; *Dermanyssus* sp. or *Liponyssus* sp. The life mode of the third genus taken, *Myotyphlus*, requires re-assessing (see below). *Pygiopsylla* contains species which occur on a number of native rodents (including *Rattus* spp.) and marsupials (CSIRO 1970). Mites of the family Dermanyssidae are known parasites of mammals, and also birds and reptiles. They feed on the blood of their hosts and are capable of transmit-

Recommendations for Wilsons Promontory National Park

1. Monitor known populations of New Holland Mice in Wilsons Promontory National Park at least once per year.

2. Gather further base-line data on the ecology of New Holland Mice at the Promontory, including data on population dynamics and composition, mortality, home range, breeding biology, dispersal patterns, diet and the degree of genetic isolation of the populations. The collection of scats and hair samples for analysis by Deakin University scientists should continue.

3. Describe fully the habitat of New Holland Mice at Wilsons Promontory; study vegetational succession on the dunes in order to implement more precisely, management requirements of New Holland Mice.

4. Search similar dune systems of Wilsons Promontory National Park and other areas of South Gippsland for further populations of New Holland Mice.

5. In the short-term, continue some slashing of the swales surrounding the dunes occupied by New Holland Mice at the Promontory to reduce the extent of Coast Tea-tree *Leptospermum laevigatum* and Coastal Wattle *Acacia sophorae* invasion on to the dunes; meanwhile, investigate the susceptibility of New Holland Mice to the proposed 1080 baiting program. In the long-term, the New Holland Mouse sites should be incorporated into the entire native grassland - open woodland restoration program, as this should conserve and enhance their habitats and ensure the species survival.

6. Investigate the potential of Wilsons Promontory heathlands to provide suitable New Holland Mouse re-introduction sites, as a long-term aim.

ting diseases (Krantz 1978). Whether or not the Dermanyssidae mites found on New Holland Mice at Wilsons Promontory transmit disease to their hosts is not known, but may be worthy of investigation. *Myotyphlus* sp. is included in the tribe Amblyopinini. Members of this tribe occur in the Neotropics as well as Australia, and until recently, were thought to be obligate ectoparasites on small mammals. However, two species of a central and southern American genus *Amblyopinus*, are known to be highly specialized predators on ectoparasites of the mammals (Ashe and Timm 1987a,b). *Myotyphlus* sp. has been previously collected from the fur of *Rattus* spp. in both Victoria and Tasmania. In addition, it has been detected free-living in the guano of bats in Victorian and New South Wales caves (Hamilton-Smith and Adams 1966).

With this evidence it is highly likely that *Myotyphlus* sp. specimens on New Holland Mice at Wilsons Promontory were using the ectoparasites (*Pygiopsylla* sp.; *Dermanyssus* or *Liponyssus* sp.) as prey items. Clearly, the relationship between *Myotyphlus* sp. and New Holland Mice could be mutualistic and not parasitic, and deserves investigation.

The management recommendations given for New Holland Mouse are not expected to adversely affect other small ground mammal species. In fact, the long-term viability of these other species would benefit by an increased knowledge of their requirements (if further monitoring proceeds), greater understanding of their habitats, and habitat enhancement through restoration and appropriate management.

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The Editors would also like to remind authors of the references to be used for articles in *The Victorian Naturalist:*

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'Reptiles and Amphibians of Australia' (1992), by Harold Cogger, Reed Books;
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